



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| <b>(51) International Patent Classification <sup>7</sup> :</b><br><b>A61K 9/00, 31/485, 9/12</b>   | <b>A1</b> | <b>(11) International Publication Number:</b> <b>WO 00/35417</b><br><b>(43) International Publication Date:</b> 22 June 2000 (22.06.00)   |
| <b>(21) International Application Number:</b> PCT/NL98/00713<br><b>(22) International Filing Date:</b> 11 December 1998 (11.12.98)<br><b>(71) Applicant (for all designated States except US):</b> PHARMA-CHEMIE B.V. [NL/NL]; 5, Swensweg, NL-2031 GA Haarlem (NL).<br><b>(72) Inventors; and</b><br><b>(75) Inventors/Applicants (for US only):</b> VERKERK, Volmar [NL/NL]; 16e, 2e Nassaustraat, NL-1052 BN Amsterdam (NL). BLOM-ROSS, Marianne, Elisabeth [NL/NL]; 8, Hortensialaan, NL-2106 CH Heemstede (NL). VAN DORT, Karin [NL/NL]; 51, Zijdelveld, NL-1421 TK Uithoorn (NL). DE VOS, Dick [NL/NL]; 36, Hofbrouck-erlaan, NL-2341 LP Oegstgeest (NL).<br><b>(74) Agent:</b> VAN DER KLOET-DORLEIJN, G., W., F.; Van Exter Polak & Charlouis B.V., P.O. Box 3241, NL-2280 GE Rijswijk (NL). |           | <b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).<br><br><b>Published</b><br><i>With international search report.</i> |
| <b>(54) Title:</b> PHARMACEUTICAL PREPARATION FOR INHALATION OF AN OPIOID  |           |   |
| <b>(57) Abstract</b><br><br><p>The present invention relates to the inhalation of opioids, such as morphine, administered as a dry powder. Opioids administered as dry powder for inhalation are intended for local treatment in the respiratory tract, or for systemic treatment following absorption in the lungs and airways. Indications for opioids dry powder per inhalation include the treatment of dyspnoea and pain. Opioids as dry powder for inhalation may be administered with the use of an inhaler, which can be described as a multi-dose reservoir system such as the Cyclovent™, or a premetered single-dose system such as the Cyclohaler™, or a premetered disposable system as the Disphaler™.</p>   |           |   |

Pharmaceutical preparation for inhalation of an opioid.

The present invention relates to the inhalation of opioids, such as morphine, administered as a dry powder.

The pharmacologic properties of opioids include effects on the central nervous system and the bowel and  
5 include analgesia, drowsiness, changes in mood, respiratory depression, reduced gastrointestinal mobility, nausea, vomiting, and miosis.

#### BACKGROUND OF THE INVENTION

10 Opioids are mainly used for the relief of moderate to severe pain. In addition, reports have been published on the use of opioids in the treatment of dyspnoea and neurally mediated mucus secretion.

In the treatment of pain as well as dyspnoea, opioids  
15 are administered parentally and orally. Inhalation of nebulized opioids solutions has been reported to be effective with lower doses and less side effects, as compared to the parental and oral route of administration. As nebulizers are widely used in clinical practice, morphine  
20 is frequently administered by the nebulized route. Reference is in this respect made to Farncombe M. Chater S and Gillin A, "The use of nebulized opioids for breathlessness: a chart review," Palliative Medicine 1994: 8; 306-312, and to Farncombe M and Chater S, "Clinical application of nebulized  
25 opioids for treatment of dyspnoea in patients with malignant disease," Support Care Cancer 1994: 2; 184-187.

The use of solutions for inhalation administered by a nebulizer has several drawbacks, such as escape of vapour through the mask during expiration and trapping of the  
30 nebulizer solution in the nebulizer. Also to inhale by means of a nebulizer takes some time, which can be aggravating for terminally ill patients.

#### SUMMARY OF THE INVENTION

35 The object of the present invention is to provide a

convenient and reliable method of administering opioids.  
More specifically, the administration is by inhalation.

The invention therefore relates to a pharmaceutical preparation for inhalation consisting of micronized  
5 particles of an opioid having a fine particle fraction of at least 10%.

For administration by inhalation, the compositions according to the invention are conveniently delivered by conventional means, e.g. in the form of a single-dose  
10 premetered system such as the Cyclohaler™ using cartridges, or a premetered disposable inhaler such as the Disphaler™, or in the form of a multidose reservoir system such as the Cyclovent™.

Examples of the pharmacologically active substances as  
15 described in general as opioids are morphine, hydromorphone, oxymorphone and codeine. Morphine is the preferred substance. The substances can be used in the form of their salts, such as alkali metal or amine salts or as acid addition salts; or as esters such as lower alkyl esters, or  
20 as solvates (hydrates), to optimise the activity, efficacy and/or stability of the substance. Morphine sulphate and morphine hydrochloride are the preferred salts to be used according to the invention.

In order to optimize or to control the properties of  
25 the inhalation powders it is sometimes useful to add excipients, which are pharmaceutically suitable and physiologically harmless. Examples of such excipients include monosaccharides (such as glucose and arabinose); disaccharides (such as lactose, saccharose and maltose);  
30 polysaccharides (such as dextrans); polyalcohols (such as sorbitol, mannitol and xylitol); salts (such as sodium chloride and calcium carbonate) or mixtures of these excipients with one another. Lactose is the preferred excipient.

35

#### EXPERIMENTAL PART

For dry powder inhalation systems the patient inspiratory effort through the device is the main force delivering and aerosolizing the formulation. Upon

inspiration the agglomerates or aggregates, which are formed during processing, should break apart and present the drug as more or less discrete particles for inhalation into the lung.

5 In order to document the dispersion characteristics, as a function of the inhaled air flow rate, in vitro performance test with the use of a impinger are performed. The basic mechanism in this experiment is impaction and the apparatus consists of several stages. The stages represent  
10 parts of the respiratory tract. In this manner the powder aerosol is characterized, in the sense of particle size distribution, on the basis of the aerodynamic behaviour of particles. The respirable fraction of a powder is defined as the mass of the particles with a diameter less than 6,8  $\mu\text{m}$ .  
15 This respirable fraction is reflected in the determination of the fine particle dose (in mg) or the fine particle fraction (% relative to the delivered dose, defined as the sum of all stages of a impinger and the throat).

The above characterization of a preparation meets the  
20 standards of the "Inhalanda" Monograph of the European Pharmacopeia, as published in Pharmeuropa 1996, p. 245-258.

#### EXAMPLES

##### **Preparation of the mixtures**

25 Morphine sulphate BP was micronized using an air jet mill (LS 100, GfM) at a pressure of 4 bar and a feed rate of 5 g/min. The particle size distribution was determined using a laser diffraction particle sizer (Malvern Mastersizer X). A mixture with lactose monohydrate was obtained by using a  
30 high-shear mixer (Robot Coupe R2) during 5 minutes. The ratio of morphine sulphate:lactose in the obtained mixture was 1:17. This mixture was used to fill the cartridges for the Cyclohaler (Example 1), to fill the Cyclovent (Example 3) and to fill the Disphaler (Example 5). All dosages  
35 weighted 25 mg. In addition pure micronized morphine sulphate was used to fill the cartridges for the Cyclohaler (Example 2), to fill the Cyclovent (Example 4) and to fill the Disphaler (Example 6). These dosages weighted 10 mg.

### Characterization of the aerosol formulations

For determination of the fine particle fraction all inhalation means were characterized by using a multi-stage liquid impactor (Copley, UK) made from glass and metal having four impaction stages and a filter (PA/PH/Exp. 12/T (96) 11 ANP). The nominal cut-off diameter of the stages is 13  $\mu\text{m}$ , 6.8  $\mu\text{m}$ , 3.1  $\mu\text{m}$  and 1.7  $\mu\text{m}$  at the operating air flow rate of  $60 \pm 5$  litres per minute. A total volume of 4 litres of air was applied. In the tests with the Cyclohaler, 10 doses were sampled. However, in the tests with the Disphaler and Cyclovent 5 doses were sampled. All stages including the filter, the throat were analyzed on morphine sulphate by using a high performance liquid chromatography (HPLC) method. The HPLC method was performed by using a Symmetry C18 250 x 4.6 mm ID column (Waters, Milford, Massachusettes, USA), a mobile phase of acetonitrile:water (50:50) with 0.1 M sodium lauryl sulphate and 0.04 M potassium hydrogen phosphate dissolved in water, and a UV detector set at 287 nm. All samples were dissolved in acetonitrile:water (50:50). All calculations were related to morphine as a free base.

## EXAMPLE 1

| Cyclohaler  |             |
|---|-------------|
|   | mg morphine |
| throat  | 0,12        |
| 5 stage 1 (< 13 $\mu\text{m}$ )   | 0,30        |
| stage 2 (< 6,8 $\mu\text{m}$ )  | 0,10        |
| stage 3 (< 3,1 $\mu\text{m}$ )  | 0,24        |
| stage 4 (< 1,7 $\mu\text{m}$ )  | 0,16        |
| filter  | 0,04        |
| 10 fine particle dose: 0,44 mg morphine                                       |             |
| fine particle fraction: 46 % (= respirable fraction;<br>< 6,8 $\mu\text{m}$ ) |             |

## 15 EXAMPLE 2

| Cyclohaler                              |             |
|---|-------------|
|   | mg morphine |
| throat                                  | 0,70        |
| 20 stage 1                              | 1,40        |
| stage 2                                 | 0,67        |
| stage 3                                 | 1,31        |
| stage 4                                 | 0,73        |
| filter                                  | 0,29        |
| 25 fine particle dose: 2,33 mg morphine |             |
| fine particle fraction: 46 %            |             |

## EXAMPLE 3

|                                      |             |
|--------------------------------------|-------------|
| Cyclovent                            |             |
|                                      | mg morphine |
| 5 throat                             | 0,20        |
| stage 1                              | 0,26        |
| stage 2                              | 0,10        |
| stage 3                              | 0,23        |
| stage 4                              | 0,17        |
| 10 filter                            | 0,06        |
| fine particle dose: 0,46 mg morphine |             |
| fine particle fraction: 45 %         |             |

## 15 EXAMPLE 4

|   |             |
|---|-------------|
| Cyclovent                               |             |
|   | mg morphine |
| throat                                  | 0,55        |
| 20 stage 1                              | 0,40        |
| stage 2                                 | 0,20        |
| stage 3                                 | 0,49        |
| stage 4                                 | 0,59        |
| filter                                  | 0,50        |
| 25 fine particle dose: 1,58 mg morphine |             |
| fine particle fraction: 58 %            |             |

## EXAMPLE 5

|                                      |             |
|--------------------------------------|-------------|
| Disphaler                            |             |
|                                      | mg morphine |
| 5 throat                             | 0,23        |
| stage 1                              | 0,39        |
| stage 2                              | 0,08        |
| stage 3                              | 0,20        |
| stage 4                              | 0,12        |
| 10 filter                            | 0,04        |
| fine particle dose: 0,36 mg morphine |             |
| fine particle fraction: 34 %         |             |

## 15 EXAMPLE 6

|   |             |
|---|-------------|
| Disphaler                               |             |
|   | mg morphine |
| throat                                  | 1,72        |
| 20 stage 1                              | 3,99        |
| stage 2                                 | 0,38        |
| stage 3                                 | 0,43        |
| stage 4                                 | 0,17        |
| filter                                  | 0,11        |
| 25 fine particle dose: 0,71 mg morphine |             |
| fine particle fraction: 10 %            |             |

The formulation administered by the described means and according to the present invention shows good dispersion characteristics, as reflected by adequate fine particle doses. This indicates that various parts of the respiratory tract can be reached. Thus diseases and illnesses in these parts of the respiratory tract can be treated adequately. Furthermore, patients with poor lung function are able to inhale the formulations according to the invention and administered by the described modes.



C L A I M S

1. A pharmaceutical dry-powder composition suitable for inhalation consisting of micronized particles of an opioid having a fine particle fraction of at least 10%.
- 5 2. A pharmaceutical dry-powder composition according to claim 1, wherein said opioid is selected from the group consisting of morphine, hydromorphone, oxymorphone and codeine.
3. A pharmaceutical dry-powder composition according to  
10 claim 1 or 2, wherein said opioid is in the form of a salt, an ester or a solvate.
4. A pharmaceutical dry-powder composition according to claim 3, wherein said salt is an alkali metal salt, amine salt or an acid addition salt, said ester is a lower alkyl  
15 ester, and said solvate is a hydrate.
5. A pharmaceutical dry-powder composition according to any of the claims 1 to 4 and a pharmaceutically acceptable carrier.
6. A pharmaceutical dry-powder composition according to  
20 claim 5, wherein said carrier is selected from the group consisting of mono-, di- and polysaccharides; polyalcohols; salts and mixtures thereof, preferably lactose.
7. Use of an opioid having a fine particle fraction of at least 10% for the preparation of an inhalation medicament  
25 for the treatment of dyspnoea and pain.

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/NL 98/00713

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|---|--|--|
| <b>A. CLASSIFICATION OF SUBJECT MATTER</b><br>IPC 7    A61K9/00    A61K31/485    A61K9/12   |  |  |
| According to International Patent Classification (IPC) or to both national classification and IPC   |  |  |
| <b>B. FIELDS SEARCHED</b><br>Minimum documentation searched (classification system followed by classification symbols)<br>IPC 7    A61K   |  |  |
| Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched   |  |  |
| Electronic data base consulted during the international search (name of data base and, where practical, search terms used)  |  |  |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>   |  |  |
| Category *  | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No.  |
| X   | WO 97 35562 A (WATTS PETER JAMES<br>;DANBIOSYST UK (GB); ILLUM LISBETH (GB))<br>2 October 1997 (1997-10-02)<br>examples 5,9<br>claims 8,10,18<br>---                 | 1-7  |
| X   | WO 92 14466 A (SMITHKLINE BEECHAM PLC)<br>3 September 1992 (1992-09-03)<br>page 7, line 20 - line 32<br>examples 7-10<br>---   | 1-7  |
| X   | WO 97 17948 A (EURO CELTIQUE SA ;ALFONSO<br>MARK (US); GOLDENHEIM PAUL (US); SACKLER)<br>22 May 1997 (1997-05-22)<br>page 7, line 30 - page 9, line 3<br>---<br>-/-- | 1-7  |
| <div style="display: flex; justify-content: space-between;"> <span><input checked="" type="checkbox"/> Further documents are listed in the continuation of box C.</span> <span><input checked="" type="checkbox"/> Patent family members are listed in annex.</span> </div>   |  |  |
| <div style="display: flex;"> <div style="flex: 1;"> <p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="flex: 1;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div> |  |  |
| Date of the actual completion of the international search<br><br><div style="text-align: center; font-weight: bold;">6 August 1999</div>  |  | Date of mailing of the international search report<br><br><div style="text-align: center; font-weight: bold;">18/08/1999</div> |
| Name and mailing address of the ISA<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016  |  | Authorized officer<br><br><div style="text-align: center; font-weight: bold;">Seegert, K</div>                                 |

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International Application No

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                            | Relevant to claim No. |
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| Y          | WO 98 31352 A (TROFAST JAN ;ASTRA AB (SE))<br>23 July 1998 (1998-07-23)<br>page 2, line 21 - line 30<br>----- | 1-7                   |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)  | Publication<br>date  |
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